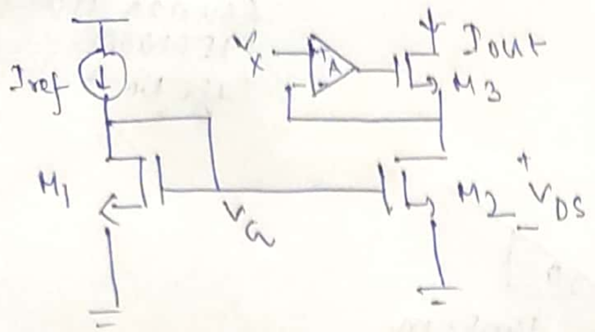
iii)



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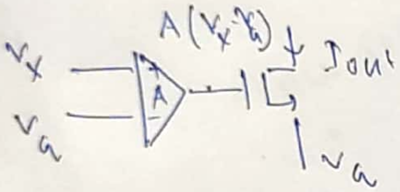
$$I_{ref} = \frac{1}{2}\mu_n C_{ox}\left(\frac{W}{L}\right)_1 (V_G - V_{th})^2 (1+\lambda V_G)$$

$$I_{out} = \frac{1}{2}\mu_n C_{ox}\left(\frac{W}{L}\right)_2 (V_G - V_{th})^2 (1+\lambda V_{DS})$$

we wish $I_{ref} = I_{out}$

$\therefore V_{DS} = V_G$



~~$I_{out} = \frac{1}{2}\mu_n C_{ox}\left(\frac{W}{L}\right)_3 [A(V_x - V_G) - V_G - V_{th}]^2 (1+\lambda$~~

$$I_{out} = \frac{1}{2}\mu_n C_{ox}\left(\frac{W}{L}\right)_3 [A(V_x - V_G) - V_G - V_{th}]^2 (1+\lambda V_{DS3})$$

or $I_{out} = \frac{1}{2} k_{n3} [AV_x - (A+1)V_G - V_{th}]^2 (1+\lambda V_{DS3})$

or $$\frac{I_{out}}{1+\lambda V_{DS3}} = \frac{1}{2} k_{n3} [AV_x - (A+1)V_G - V_{th}]^2$$

or $$\frac{2 I_{out}}{k_{n3}(1+\lambda V_{DS3})} = (AV_x - (A+1)V_G - V_{th})^2$$

or $$V_x = \frac{1}{A}\left[\sqrt{\frac{2I_{ref}}{k_{n3}(1+\lambda V_{DS3})}} + V_{th} + (A+1)V_{GS1}\right]$$ since $V_G = V_{GS1}$

This value guarantees $I_{out} = I_{ref}$

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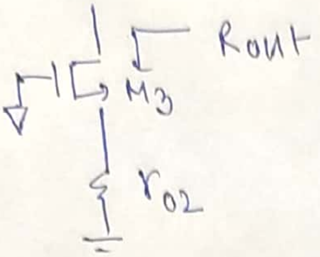
For deriving R_{out}



$R_{out} = r_{o3} + (1+g_{m3}r_{o3})R_S$ $\quad R_S$ = source resistance

$= r_{o3} + r_{o2}(1+g_{m3}r_{o3})$

$= r_{o2}+r_{o3}+ g_{m3}r_{o2}r_{o3}$ (Ans)

since for finding the ~~out~~ output resistance V_{in} is shorted

$r_{o2} = \cancel{\frac{1}{\lambda I_{ref}}}\ \frac{1}{\lambda I_{out}}$

$r_{o3} = \frac{1}{\lambda I_{out}}$

$g_{m3} = k_{n3}V_{ov3}$
$= k_{n3}(V_{GS3}-V_{th})$

All the parameters are for the time when I_{out} current flows